

Parallelization of Sigma Point and Particle Filters, Phase I

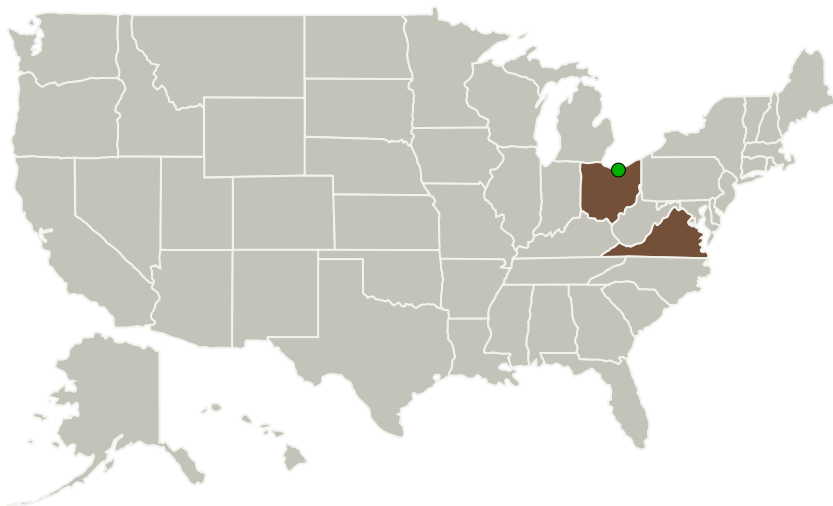
Completed Technology Project (2012 - 2012)



Project Introduction

Research on utilizing inexpensive and personal-level parallel computing architectures to speed up the implementation of the class of particle filters is proposed. This study will leverage NVIDIA Graphics Processing Units (GPUs) and multi-core CPUs that are quickly becoming commonly available for engineering communities. Parallelization of the Unscented Kalman filter and the bootstrap particle filter with applications in INS/GPS integration and the orbital determination problem will be the focus of the phase I research. This research will contribute to upgrading the current fleet of NASA navigation software which heavily rely on Kalman filters and EKF and are quickly becoming outdated. Over the last couple of decades, great advancement has been made in improving filter accuracy in nonlinear applications with non-Gaussian noise models. One of the advanced techniques is particle filters which, if properly applied, are more accurate than the EKF for nonlinear and non-Gaussian applications. One drawback of the particle filters is the excessive computational burden if implemented on a serial computer. However, since the majority of the computation can be carried out simultaneously, the particle filters inherently are well suited for parallel computing. The objective of the Phase I effort is to leverage GPUs and multi-core CPUs to exploit such parallelism. With the performance of these devices improving at a rapid pace, it is anticipated that they will quickly find their way to onboard avionics, and this research paves the way for implementing particle filters in real-time applications. This will bring unprecedented accuracy and applicability of particle filters to aircraft and spacecraft navigation analyses for NASA and a wide range of non-NASA applications.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Analytical Mechanics Associates, Inc.	Lead Organization	Industry	Hampton, Virginia
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations

Ohio	Virginia
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Project Transitions

**February 2012:** Project Start**August 2012:** Closed out**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/138398>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Analytical Mechanics Associates, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Haijun Shen

Co-Investigator:

Haijun Shen

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Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
 - └ TX17.2 Navigation Technologies
 - └ TX17.2.1 Onboard Navigation Algorithms

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System